

### REMARKS

This Amendment is in response to the Office Action dated March 13, 2003. In the Office Action, the Examiner rejected claims 88-92, 97-99 and 101-125 under 35 U.S.C. § 103(a) as being unpatentable over Sesko et al. (U.S. Patent No. 6,205,159) (hereinafter *Sesko*) in view of Deacon. (U.S. Patent No. 6,205,151) (hereinafter *Deacon*). Claims 90-92 were objected to for informalities. New claims 126-128 identified as being directed to an independent or distinct invention, and were withdrawn from consideration. The claims are specifically cancelled in the present amendment and response. Applicants note that it is believed the Examiner intended to withdraw claims 126-128 (as indicated on the Office Action Summary), rather than the claims 125-128, as indicated in on pages 2 and 3. Claims 97, 103, 106 and 113 are amended herein. Claims 88, 89, 91, 92, 97-99, and 101-125 remain pending in the application.

With regard to the Examiner's acknowledgement of the amendment filed on 13 May 2002, the Applicants respectfully suggest that the acknowledgement actually corresponds to an amendment presented via facsimile on October 30, 2002. With regard to the objection of claims 90-92, the Applicants respectfully direct the Examiner's attention to an amendment filed via facsimile on November 26, 2002 in which claim 90 was cancelled and claims 91 and 92 were amended to depend from claim 88. A copy of the amendment is attached hereto in the event that the faxed version of the amendment was never received.

### CLAIM REJECTIONS - 35 U.S.C. § 103

To establish a *prima facie* case of obviousness, there must first be some suggestion or motivation to modify a reference or to combine references, and second be a reasonable expectation of success. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. Third, the prior art reference (or references when combined) must teach or suggest all the claim limitations. M.P.E.P. §

706.02(j) from *In Re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). Where claimed subject matter has been rejected as obvious in view of a combination of prior art references, a proper analysis under § 103 requires, *inter alia*, consideration of two factors: (1) whether the prior art would have suggested to those of ordinary skill in the art that they should make the claimed device; and (2) whether the prior art would also have revealed that in so making, those of ordinary skill would have a reasonable expectation of success. Both the suggestion and the reasonable expectation of success must be founded in the prior art, not in the Applicants' disclosure. *Amgen v. Chugai Pharmaceutical*, 927 F.2d 1200, 18 USPQ2d 1016 (Fed. Cir. 1991), *Fritsch v. Lin*, 21 USPQ2d 1731 (Bd. Pat. App. & Int'f 1991). An invention is non-obvious if the references fail not only to expressly disclose the claimed invention as a whole, but also to suggest to one of ordinary skill in the art modifications needed to meet all the claim limitations. *Litton Industrial Products, Inc. v. Solid State Systems Corp.*, 755 F.2d 158, 164, 225 USPQ 34, 38 (Fed. Cir. 1985).

The examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references. M.P.E.P. § 70602(j) from *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985). Obviousness cannot be established by combining references without also providing evidence of the motivating force which would impel one skilled in the art to do what the patent applicant has done. M.P.E.P. § 2144 from *Ex parte Levengood*, 28 USPQ2d 1300, 1302 (Bd. Pat. App. & Inter. 1993) (emphasis added by M.P.E.P.).

With regard to the rejection of claims 88-92, 97-99 and 101-125, the Examiner states "Sesko et al. teach a tunable filter apparatus Fig 2A, comprising a grid generator 4 positioned in an optical path and configured to generate a first transmission peaks corresponding to channels of a selected wavelength grid, see col. 11, lines 46-49; and a channel selector 5 positioned in the optical path and configured to generate a second

plurality of transmission peaks, see col. 11, lines 52-56 and col. 12, lines 46-48." The Examiner further states, "Sesko et al. fails to teach the grid generator is configured to generate a plurality of transmission peaks. In addressing this deficiency, the Examiner then states, "Deacon teaches that use of a single or plurality of transmission of transmission peaks for vernier tuning is well known in the art see col. 13. lines 8-37 and col. 31, line 23-col. 32, line 24 and within the general skill of a worker in art to select a known method on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416."

With respect to the foregoing statements and assertions, the Applicants respectfully suggest that the Examiner has the operations performed by the foregoing grid generator (solid etalon) 4 and channel selector 5 of *Sesko* reversed: The solid etalon 4 generates a plurality of transmission peaks ("discrete comb of wavelengths to which the laser may be tuned", Col. 11, lines 46-49), while the channel selector (liquid crystal etalon 5) generates a single transmission peak that is shifted across the comb of wavelengths to select a transmission wavelength, as Figure 3.

With respect to the statement about Vernier tuning being well-known in the art, the applicants acknowledge that Vernier tuning as applied to distributed feedback (DFB) and distributed Bragg Reflector (DBR) lasers was known at the time of the present invention (see, e.g., column 10 of Fay et al., US. Patent No. 6,289,032). While *Deacon* may disclose a type of Vernier tuning that is applicable to DWDM communication systems, the Examiner does not indicate how *Deacon's* mechanism for employing Vernier tuning could be applied to *Sesko* to yield an apparatus that would anticipate the invention recited in the independent claims, 88, 97 and 101. Merely stating that Vernier tuning was known in the prior art and then asserting that Vernier tuning could thus be applied to a prior art reference (i.e., *Sesko*) to obtain the claimed invention without indicating how the teachings of the references would be combined does not meet the requirements for establishing a *prima facie* case of obviousness.

Consider, for example, independent claim 88, which recites:

88. A tunable optical filter apparatus, comprising:

a grid generator to be positioned in an optical path of an optical signal and to generate a first plurality of transmission peaks at respective wavelengths corresponding to optical communication channels within a selected wavelength range; and

a channel selector to be positioned in said optical path to be optically coupled to the grid generator and to generate a second plurality of transmission peaks at respective wavelengths within said wavelength range, said channel selector including means for tuning the second plurality of transmission peaks relative to the first set of transmission peaks such that a single pair of respective transmission peaks from among the first and second plurality of transmission peaks having a common wavelength may be aligned,

wherein the tunable optical filter enables a portion of the optical signal having a wavelength corresponding to the common wavelength of the aligned transmission peaks to pass through while substantially attenuating portions of the optical signal having other wavelengths.

*Deacon* does not disclose the use of a grid generator and a channel selector in the embodiment employed for Vernier tuning. This embodiment is shown in Figure 17, and corresponds to a narrow band coupler. The coupler enables signals to be coupled ("The device 1700 therefore may act as a frequency selective cross connector or optical switch, including the subset function of add-drop and tuned detector." Col. 30, lines 43-45). This is accomplished by concurrently tuning the two gratings 1330 and 1730. The objective is to couple a signal received as power input 1302 to be output at output 1706 power 1706. When the gratings are tuned to the same resonance, the signals are coupled; otherwise, there is no coupling of power input 1302 to waveguide 1726.

The tuning elements employed by *Deacon* are not suited for use in the *Sesko* apparatus. *Sesko* employs an external cavity diode laser (ECDL) configuration, wherein various optical components are disposed within a laser cavity defined by a reflector and a partially-reflective facet of a semiconductor gain medium, as is well-known in the art. In contrast, *Deacon* employs a waveguide-based lasing apparatus including a region of the waveguide that is fabricated to produce a Bragg grating in the periphery of the waveguid, while another section of the waveguide is formed in a semiconductor laser chip (110 – see Figure 1). There are various resonance characteristics for waveguides that enable the Bragg grating region to produce a tunable resonance; however, these characteristics are incompatible for use in an ECDL, which employs an entirely different optical feedback mechanism to support tunable lasing resonances. Thus, there would be no motivation or likelihood of success to combine the tuning mechanism of *Deacon* (the Bragg grating region of a waveguide) with the *Sesko* apparatus.

Thus, we are left with the possibility of employing Vernier tuning in the *Sesko* apparatus. This leads to the concept of employing *Sesko's* liquid crystal Fabry-Perot interferometer to function as a channel selector that produce the second set of passbands (transmission peaks) having a free spectral range (FSR) slightly different than the FSR for the grid generator.

The FSR for a liquid crystal Fabry-Perot interferometer (etalon) (LC-FPI) is defined by the following relationship:

$$FSR = \lambda^2 / (2 \times n_{lc} \times L_{lc}) \quad (1)$$

where  $\lambda$  is the resonant wavelenth,  $n_{lc}$  is the index of refraction for the liquid crystal, and  $L_{lc}$  is the thickness of the liquid crystal material.

Rearranging equation (1) yields:

$$n_{lc} = \lambda^2 / (2 \times L_{lc} \times FSR) \quad (2)$$

An  $n_{lc}$  value of approximately 1.54 is derived from parameters stated in Sesko (1550 nm wavelength,  $L_{lc}$  of 15 microns (15000 nm), FSR of 52nm –see column 12, lines 48-50) when  $n_{lc}$  is solved for using equation 2.

As discussed in both the present application and Sesko, the grid generator is employed to generate a wavelength (channel frequency) grid corresponding to a desired communication band, such as the ITU grid. Depending on the implementation, the ITU grid may have a channel spacing corresponding to the FSR for the grid of 50 or 100 GHz. This translates into a wavelength of approximately 0.4 nm or 0.2 nm respectively, at 1550 nm.

Let us solve for liquid crystal Fabry-Perot interferometers parameters needed to implement Vernier tuning corresponding to the 50 GHz grid, which is easier than implementing the 100 GHz grid (the FSR necessary to implement a 100 GHz grid is one-half that of necessary for implementing a 50 GHz grid) . In accordance with principles disclosed in the present application, the difference between the FSR of the grid generator and the channel selector can be derived from equation III on page 16. In this case the difference is +/-0.39 GHz. Thus, for practical purposes, the channel selector FSR can be considered to be equal to the grid generator FSR of 50 GHz, or 0.4 nm.

Therefore, the liquid crystal Fabry-Perot interferometer would need to have an FSR of approximately 50 GHz or 0.4 nm. The corresponding etalon thickness can be derived by rearranging equation 1 to solve for  $L_{lc}$ :

$$L_{lc} = \lambda^2 / (2 \times n_{lc} \times \text{FSR}) \quad (3)$$

Solving equation (3) yields a liquid crystal etalon thickness of 1.95 mm.

Thus the ratio between the thickness of Sesko's disclosed liquid crystal Fabry-Perot interferometer and the new thickness that would be necessary = 1.95 mm / 15  $\mu$ m = 130.

Further note that under one of the claimed embodiments of the present invention, the tuning may be "slewed" between all channels of the grid using an entire change in center frequency of an amount that is equal to a single channel spacing (0.4 nm) under the Vernier tuning technique.

The resonant wavelength for a liquid crystal Fabry-Perot etalon is

$$\lambda = (2 \times n_{lc} \times L_{lc})/m \quad (4)$$

where m is an arbitrary integer. For a given frequency (e.g., 1550 nm) and index of refraction n,  $L_{lc}/m$  will be a constant from equation 4. Thus,  $\Delta\lambda$  is proportional to  $\Delta n_{lc}$ .

Continuing, let's contrast the tuning techniques. In *Sesko*, the index of refraction of the liquid crystal etalon is adjusted such that the single filter passband is shifted across the entire wavelength grid, or requires a minimum change of 0.4 nm x 128 channels = 51.2 nm (*Sesko* uses the figure 52 nm). In contrast, under the Vernier tuning technique of the present invention, the channel selector pass bands are shifted across only a single channel width, or 0.4nm. Thus, in order to implement a channel selector with a liquid crystal etalon, the sensitivity of the control system would need to be increased by approximately 128 times to produce the same channel selectivity.

For example, consider a frequency change from 1550 nm to 1550.4 nm in a base bandpass wavelength for the channel selector (which would shift from the first channel to the 128<sup>th</sup> channel using the Vernier tuning in accordance with one embodiment of the invention). This could be effectuated by a change in n for the liquid crystal,  $\Delta n_{lc}$ , of  $1550.4 - 1550/1550 = 2.58 \times 10^{-4}$  or .026%. Furthermore, the tuning step between adjacent channels would be only .026%/128 = .00020%!

In contrast, under the tuning technique disclosed in *Sesko*, the corresponding change  $\Delta n_{lc}$  is 128 times greater, or 3.3%. The control system for implementing this magnitude of change is much simpler, and in *Sesko* comprises a 10 Volt peak-to-peak signal (Col 6., lines 9-10).

As discussed in Sesko, the change in the index of refraction of the liquid crystal etalon is effectuated by applying a voltage across the liquid crystal. In particular, Sesko states:

Liquid crystals have a large refractive index anisotropy. When no voltage  $V$  is applied the liquid crystal molecules orient themselves with the (*sic*) their ordinary axis parallel to the glass substrates. When a voltage  $V$  is applied to the liquid crystal, the molecules rotate so that the refractive index gradually changes from the ordinary refractive index to the extraordinary refractive index. The change in the refractive index changes the optical path length between the two mirrors, thereby tuning transmission spectra of the LC-FPI according to the above relationship. Liquid crystal based filters require only 10's of volts to tune over a large range. Since the power consumption is low, they may be powered using conventional batteries. (Col. 2 line 58 – Col. 3 line 4).

In further detail, Sesko identifies the 10V peak-to-peak input is required to cover the entire 52 nm wavelength bandwidth. This is enabled, in part, due to the relatively large width of the channel selector transmission curve (transmission curve (B) in FIG. 3) in comparison to the very narrow transmission peaks produced by the static etalon 4 (shown in transmission curve (C)). As a result of this large width, the accuracy of the center wavelength filtered by the channel selector is greatly reduced. Accordingly, the accuracy of the control system would need to be approximately 10 volts/128 channels volts or about  $1/13^{\text{th}}$  of a volt. In sharp contrast, in order to obtain a change of a single channel under Vernier tuning, the change in voltage supplied across the liquid crystal material would need to be extremely small and precise (approximately  $1/1600^{\text{th}}$  of a volt). This would, by necessity, make the control system more complex and expensive. Furthermore, since the required voltage range corresponding to the entire communication grid bandwidth would be approximately 128 times smaller, a voltage conversion means, such as a DC-DC converter, would be necessary to enable use of a low cost power source, such as a battery, if, in fact, this were even practical.

Another consideration relates to the dramatic increase in the liquid crystal etalon thickness that would be required to achieve an FSR of a fraction of a nanometer. As



discussed in the Background of the Invention section of *Sesko* and above, the change in the liquid crystal index of refraction results from a voltage applied across the liquid crystal material disposed between a pair of electrodes (*i.e.*, indium tin oxide (ITO) 3 in Figure 1). It is not clear if this relationship is linear or non-linear with respect to liquid crystal material thickness, or how such a thick material would behave. For comparison, a liquid crystal Fabry-Perot etalon discussed in U.S. Patent No. 5,150,236 to Patel (discussed in the Background of the Invention section of *Sesko*) employs a somewhat similar configuration with a Fabry-Perot cavity length of 11  $\mu\text{m}$  and yields an FSR of approximately 75nm.

In summary, applicants respectfully assert that the combination of *Sesko* and *Deacon* do not support a *prima facie* obviousness rejection of claim 88, or any of the other pending independent or dependant claims. Clearly, the elements of *Sesko* and *Deacon* cannot be combined in any way to yield the claimed invention, there is no motivation found in either reference to modify the liquid crystal Fabry-Perot interferometer of *Sesko* to produce a tunable filter having a second set of transmission peaks having an FSR that is slightly offset from the FSR of a grid generator, and there would be no expectation of success in combining such elements if they existed. Accordingly, applicants respectfully assert that the rejections of claim 88, and each of the claims dependent thereon are improper and should be withdrawn.

With regard to independent claim 101, this claim is a means for claim substantially analogous to the tunable filter apparatus of claim 88. Accordingly, applicants respectfully assert that amended claim 101, and each of the claims dependent thereon is in condition for allowance for reasons similar to those presented above with respect to claim 88.

With regard to independent claims 97-99 and 116-125, these claims are method claims corresponding to operation of the apparatus of claim 88. Accordingly, applicants

respectfully assert that each of these claims are patentable for reasons analogous to those presented above in support of the allowance of claim 88.

It is noted that although the tunable filter apparatus and corresponding methods for using the same of the present invention are primarily described in the context of there use in an ECDL, this is not to be limiting. As recited in the claims, the tunable filter apparatus is suitable for tuning optical signals in general by placing the filter components in an optical path, and thus may be employed in other types of optical devices, such as optical switches, optical circulators, etc.

#### Conclusion

Overall, none of the references singly or in any motivated combination disclose, teach, or suggest what is recited in the independent claims. Thus, given the above amendments and accompanying remarks, independent claims 88, 97, 101, and 116 are now in condition for allowance. The dependent claims that depend directly or indirectly on these independent claims are likewise allowable based on at least the same reasons and based on the recitations contained in each dependent claim.

If the undersigned attorney has overlooked a teaching in any of the cited references that is relevant to the allowability of the claims, the Examiner is requested to specifically point out where such teaching may be found. Further, if there are any informalities or questions that can be addressed via telephone, the Examiner is encouraged to contact the undersigned attorney at (206) 292-8600.

#### *Charge Deposit Account*

Please charge our Deposit Account No. 02-2666 for any additional fee(s) that may be due in this matter, and please credit the same deposit account for any overpayment.

Respectfully submitted,

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